ESA-082-2, Seneca Foods – Janesville, WI, Plant Final Public Report

Company	Seneca Foods Corporation	**ESA Dates**	August 15-17, 2007
Plant	Janesville, Wisconsin	**ESA Type**	Compressed Air
Product		**ESA Specialist**	Frank Moskowitz

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
As an activity for the United States Department of Energy's Save Energy Now program, an Energy Savings Assessment (ESA) was performed at Seneca Foods Corporation in Janesville Wisconsin. Seneca is a leading manufacturer in fresh pack canning of asparagus, peas, corn, potatoes, carrots and mixed vegetables. Energy sources to the plant include electricity and natural gas.
The assessment, was conducted August 15-17, 2007. The ESA was led by DOE compressed air qualified specialist, Frank Moskowitz, of Draw Professional Services.

Objective of ESA:
The ESA had two main objectives. The first of these was to develop and present viable energy savings opportunities for the compressed air system; the second was to provide hands-on training and demonstration of the process of performing an energy savings assessment. To investigate energy savings opportunities, compressed air system amperage and pressure data were collected, LogTool was used to process the collected data and AIRMaster+ was used to model compressor energy use and potential energy efficiency measures (EEM's). These activities were performed in concert with site personnel in order to provide hands-on training.

Focus of Assessment:
The assessment focused Seneca's compressed air system. This system consists of four rotary screw air compressors, all located within or near the boiler room. Compressor 1 and 2 are 150 hp Gardner Denver water cooled lubricant injected rotary screw compressors. Each utilizing variable displacement as a control. Also known as turn valve by Gardner Denver. Compressor 3 is an air cooled 150 hp Gardner Denver lubricant injected rotary screw compressor also with turn valve. Compressor 4 is a 75 hp Gardner Denver air cooled with modulated inlet as a control. Discharge pressure was recorded at a common compressor discharge line and after cleanup, see. 1335 acfm is the average production airflow which will hold 105 psig on the production floor. Compressors are turned on and off manually to achieve the desired pressure which presently results in excess horse power online and all in part load.

Approach for ESA:
The general approach for this ESA included

- Review of compressed air distribution systems in the plant, including size and type of compressors
- Review of compressed air support equipment (filters and dryers)
- Discussion of end-uses in the plant
- Discussion of plant operating schedule and compressor operating schedule
- Measurement of compressor operating characteristics
- Brief measurement of compressor and distribution system operations
- Data analysis with LogTool
- Energy analysis with AIRMaster+, including development of EEM's

Plant personnel were given hands-on training using LogTool and AIRMaster+. Since site personnel will use their own data logging equipment, the DOE representative collected the data for this exercise under observation by plant personnel.

In order to collect the required 48 hours of data which LogTool requires to establish daytypes, all data collection was installed within the first few hours of arriving on site. Site personal were extremely helpful in accomplishing this task. A meeting was held that afternoon to introduce the concepts and routines of the next few days. The stated objective of developing and presenting compressed air EEM's was accomplished by using compressor operating characteristic data measured during this ESA and using daytype information created by the LogTool software. Information was input to AIRMaster+ and EEM's were developed.

General Observations of Potential Opportunities:

- Note that energy saving opportunities are identified as Near Term, Medium Term, Long Term opportunities. See definitions below:

  - **Near term** opportunities would include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
  - **Medium term** opportunities would require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carry out further engineering and return on investment analysis.
  - **Long term** opportunities would require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

Energy Opportunities Explained:

1. **Reduce Air Leaks by 80 scfm (Near term)**
   - Production machines use many valves and controls that are somewhat difficult to get to and often are overlooked when a leak inspection is attempted. Small leaks can develop on fittings and hoses that are virtually undetectable do the high noise level in the plant.
   - During no production, there still is 64 kW from a 75 hp compressor running to keep up with leaks and open blowing left on.

2. **Use automatic sequencer**: **(Medium term)**
   - #1 and # 2 turn valves were stuck and the compressors were modulating using their inlet valves which is very inefficient.
   - Using two different compressors can achieve savings. A sequencer will select the proper number of compressors to hold a target pressure and shut off the others.

3. **Lower Compressor Discharge By 10 PSIG (Near Term)**

- Some equipment is thought to require 110 psig in order to operate correctly. These were thought to be valid high pressure requirements. I took some point of use pressure measurements at (potential higher pressure required lines) and discovered that pressure actually was down to the high 80's. FRL's and point of use connections were the real culprits here. If local piping restrictions are eliminated, then the pressure can be lowered throughout the plant.

Additional projects to consider:

Open blowing is common place when a product needs to be dried or blown clean. It is a very expensive way of performing this task. Seneca is currently using a blower to replace all open blowing. This will serve to reduce the demand and allow one compressor to be turned off.

Condensate removal:
Presently all condensate is removed using float type drains. These are frequently found stuck closed and not working or could even be stuck open and wasting air down the drain. Some filters have closed ball valves and cannot drain at all unless someone does this task.

Seneca could replace the existing drains with "zero airloss" drains. No compressed air is used to release the condensate. Some types are electrical powered and some are pneumatic only. Prices vary from $200 to $700 each.

Point of use components (Maintenance)
Many production machines have valves, regulators, tubing and controls that are in need of repair or replacement. All internal controls on production machines should be operating and visible to allow adjustment.

On the topic of maintenance and quality issues: I heard many complaints of moisture condensed out in the air lines. There are two Airtek dryers in the compressor room. Each is rated for 800 scfm. One is offline, the existing piping system forces all the compressed air from three 150 hp compressors (1800 scfm) through the two 800 scfm dryers. Even if both dryers are working correctly, the associated pressure drop and decayed dewpoints warrant a re-configuration of this arrangement. See my suggestions for modifications at the end of this report.

Velocity in pipe:

The more flow you try to put through a pipe the greater the pressure drop will be. Pressure drop in a pipe increases with the square of the increase in flow. Which means if you double the flow, the pressure drop will increase four times what is was!
Distribution piping should be sized so that the air velocity within the pipe does not exceed 30 ft/sec. Higher velocities may cause condensate to be blown across a condensate drop leg, and cause lager pressure excursion to occur. The following equation explains the sizing process:

$$a = \frac{144 \text{ x } Q \text{ x } P_a}{V \text{ x } 60 \text{ x } (P_d + P_a)}$$

Where:
a = Cross-sectional area of the pipe bore, in^2
Q = Flow rate, ft^3/min free air
Pa = Prevailing atmospheric absolute pressure, psia
Pd = Compressor discharge gauge pressure (or line pressure), psig
V = Design pipe velocity, ft/sec (we will use 30)

$$a = \frac{\pi \ x \ d^2}{4} \quad \text{or} \quad d = \sqrt{\frac{ax4}{\pi}}$$

Since it is "a" the area of the pipe we are interested in, let's use these equations to the left and end up with "d" in inches for diameter.

Where:

a = Cross-sectional area of pipe bore, in^2
d = Pipe bore diameter, in.

With three 150 hp compressors operating, there is a potential of 1800 scfm to flow through 3 inch pipe. If only two were piped in the flow would be 1200 maximum.
Here is the equation for sizing a pipe for the 1200 scfm of air and keeping the velocity at 30 ft per second at 100 psig.

$$a = \frac{144 \ x \ 1200 \ x \ 14.5}{30 \ x \ 60 \ x \ (100 + P_a)} = 12.157 \ in^2 \qquad \text{Solving for d:} \qquad d = \sqrt{\frac{12.157 x 4}{\pi}} = 3.9 \text{ inches}$$

If we only have two 150 hp compressors sharing a pipe header, the diameter should be 3.9 inches or a 4 inch pipe.

If we modify the supply side piping we can eliminate the pressure drops and lower pressure without incident.

Option one is to modify #3 only to bypass the existing dryers and enter into the main header. A new mist eliminator filter has replaced the two original ones on the dryer and the check valve and strainer are gone. A 3000 gallon receiver is mounted for control and stability. The receiver can be mounted outside the compressor room or building.

<u>Option two</u> A new dryer is installed for the 75 hp and now it can bypass the original dryers and go directly to the main header along with #3. Since they will both have their own dryers they only need to enter the header upstream of the new mist eliminator filter.Depending on how much demand flow Seneca can reduce, will determine the proper pipe size to be used on all future modifications. All internal piping from the 150's should stay 3 inch and the 75 is OK with 2 inch. But the combined header that feeds the main loop is undersized and should be upgraded using the calculation on the previous page.

Conclusion:

Seneca Foods in Janesville Wisconsin now has a brand new understanding and awareness of their compressed air system. They will go from operating all three 150 hp 306 kW to only operating two compressors at 205 kW. That is a 30% decrease in energy while maintaining a more stable and consistent pressure.

During the session, participants:

- Received a compressed air training overview,
- Learned to use the DOE's software tools to identify energy-saving opportunities and to optimize their compressed air systems,
- Identified best practices that can be shared across their other companies.
- Identified a list of energy-saving opportunities for the Janesville plant.